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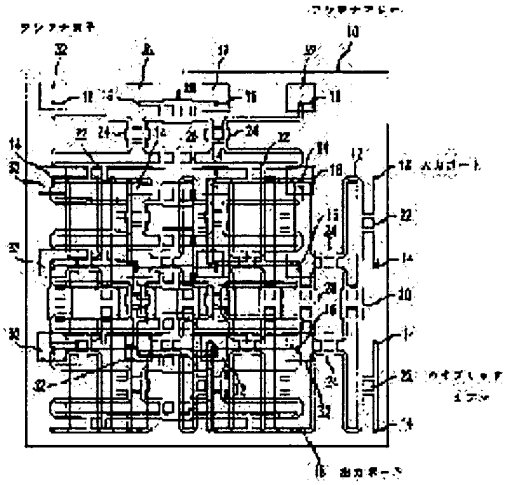
(54) MULTI-LAYER INTEGRATED POWER DISTRIBUTER



(57)Abstract:

PROBLEM TO BE SOLVED: To select a proper transmission line based on signal amplitude, signal interference and multiple-path distortion by providing plural input ports and plural output ports to the distributer and connecting one input port to a corresponding output port of a 1st array so as to utilize a directivity beam antenna.

SOLUTION: Each Butler matrix 12 of a mutli-layer integrated antenna array 120 has four input ports 14 and four output ports 16, 18. The input ports 14 are decoupled from the other input ports 14 so that no specific loss is caused even when input signals are coupled at the same frequency band. The Butler matrix 12 is so configured that a signal applied to one input port 14 is equally distributed to all the output ports, and each signal at each output port has a same amplitude substantially but phases of the outputs differ from each other. The input ports 14 of the matrix are coupled with a cross network 20 via a hybrid coupler 22.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the equipment and the method for the directional-antenna beam separation for a high-speed radio communications system.
[0002]
[Description of the Prior Art] Communication system grew quickly and is developed with the personal communication system, the inside-of-a-house radio network, and the mobile cellular radio network. The present data transmission rate is restricted to about 10 Mbps(es) needed now by natural phenomena, such as a multipath strain generated at the time of transmission, signal-amplitude degradation, and signal interference. However, in order for the prediction for future communication system to cope with the amount of data expected in transmission on such a system, it is shown that the data speed of these 10Mbps(es) is not suitable. In order to raise a data transmission rate, communication system with the function to conquer such a natural phenomenon is required.
[Problem(s) to be Solved by the Invention]
[0003] In order to raise data speed, the attempt in which an antenna element is combined with an adaptation coupler occurs. Furthermore, in order to correct a signal-to-noise ratio and to decrease signal interference and a multipath strain, the signal quality of various antenna elements is analyzed and technology chosen from the best combination of the antenna sector of a transmitter and a receiver is put in practical use. however, the technology which carries out the sample of the suitable plan and chooses it needs active elements, such as a low noise preamplifier for receivers, and/or high interest profit amplifier for transmitters, for a type target in each antenna element Moreover, if a high directivity adaptation antenna array is adopted as the remote transmitter and remote receiver which have many active elements, the cost of a transmitter and a receiver (the transmitter and receiver which operate by millimeter frequency spectrum especially) will become remarkably high.
[0004] Moreover, the standard analyzed in order to judge the best transmission line is a signal amplitude. for example, Thomas The antenna which has 60-degree isotropic antenna which is six pieces used for transmitting and receiving data is indicated by description entitled "-four challenges which make technology for radio intercommunication possible and four solutions" of A. free BAGU. The best correspondence relation of the signal between the transmitter in each data transmission and a receiver sector is specified by a signal sampling and the selection protocol. The standard on which which transmission and a receiving-antenna sector are used for

judging whether a desired signal is offered by a sampling and the selection protocol is a signal amplitude. However, it is not necessarily a path with the optimal transmission line chosen to use a signal amplitude independently.
[0005] Therefore, the communication system which chooses a suitable transmission line based on a signal amplitude, signal interference, and a multipath strain using a directive beam antenna is required. Moreover, the directive beam antenna array of the low cost used in communication system is required.
[Means for Solving the Problem]
[0006] this invention stops power consumption, makes a scope large, and improves the efficiency of an antenna array, and offers the multilayer streamline antenna array structure of a low manufacturing cost. A multilayer antenna array contains the 1st layer which has the switch matrix (a diode array switch matrix is desirable) in which a selection control is possible. A switch matrix has input port and two or more output ports. The variation rate of the 2nd layer which has the 1st array of the Butler matrix is carried out from the 1st layer. Each Butler matrix array has two or more input port and two or more output ports, and is connected to the switch matrix output port to which one input port is equivalent. Desirably, the 1st array of the Butler matrix arranges the phase of the input signal in alignment with the X-axis, and is constituted. The variation rate of the 3rd layer which has the 2nd array of the Butler matrix is carried out from the 2nd layer. Each Butler matrix array for the 3rd layer has two or more input port and two or more output ports, and one input port is connected to the output port to which the 1st array corresponds. Desirably, the 2nd array of the Butler matrix arranges the phase of the input signal in alignment with the Y-axis, and is constituted. Moreover, an antenna array contains the 4th layer which has two or more antenna elements, such as a patch antenna placed on it. Each antenna element is combined with the output to which the 2nd array of the Butler matrix corresponds.
[0007] Desirably, each class of a multilayer antenna array consists of stripline structures. Stripline structure is arranged around each class and contains two parallel copper ground planes in which the variation rate was carried out by the dielectric material from there.
[0008] Moreover, this invention offers the communication system for high-speed radio data transmission. Communication system contains at least one multilayer antenna array which has two or more antenna elements arranged on the 1st layer combined with at least one Butler matrix array arranged on the 2nd layer. Desirably, the Butler matrix array has two or more outputs with which one output is combined with one antenna element. Furthermore, the Butler matrix array has two or more inputs alternatively combined with a data transmission signal. A transmitter network is offered in order to generate and process the data transmission signal for transmission by the antenna array. A transmitter network contains in one input of at least one Butler matrix array alternatively the output port which can connect. A processor is combined with a transmitter network and a means to connect the output port of a transmitter network to at least one of two or more of the input port of the Butler matrix array.
[0009] It is combined with a multilayer antenna array and communication system includes further the receiver network constituted so that a data transmission signal may be received.
[0010] A selection means to judge which optimal transmitter antenna element and which receiver antenna element a communication system processor offers a transmission line

with desirably is included. The judgment of the optimal transmission line is based on a signal-to-noise ratio and a multipath signal strain.
[0011] Moreover, this indication offers the method of judging the optimal transmission line in a signal-to-noise ratio and the radio-transmission network of the narrow beam based on the multipath signal strain.
[0012]
[Embodiments of the Invention] This indication is related with the line switching in a transmitter and a receiver antenna array, in order to offer a directional-beam width-of-face function, the communication system which uses the array of power distribution apparatus, such as the Butler matrix coupler, and. It enables communication system to judge and choose the transmission line which has the optimal signal quality with such narrow-beam width of face. As shown in drawing 1 , by being integration-ized by multilayer structure, this multilayer structure stops power consumption, and extends a scope, and the antenna array 10 used for communication system improves the efficiency of an antenna array, and makes a manufacturing cost lower.
[0013] In addition to high-speed outdoor radio, such as cellular communication, the communication system by this invention will be used also for high-speed inside-of-a-house radio. The publication of the integrated antenna array shown in drawing 1 -7 is related with the typical antenna array structure for inside-of-a-house radio application. In inside-of-a-house radio, beam width 15 degrees or less is desirable in the visible region of a semi-sphere form (namely, 360 degrees). In order to fulfill this standard, seven 16-element array antennas supplied by the Butler matrix are used.
[0014] Drawing 2 and 3 illustrate the integrated stripline structure and the corresponding schematic diagram of one 4x4 Butler matrix 12 used by the multilayer integrated antenna array 10. Each 4x4 Butler matrix 12 has four input port 14 and four output ports 16 and 18. Even if a signal is combined by the same frequency band, each input port will be decoupled from another input so that there may be no peculiar loss. Although the Butler matrix will be constituted so that the signal applied to one input port may be divided equally to all output ports, and the signal of each output port will have the same amplitude substantially, the phases to each output differ. With this composition, the phase of the signal from an output port forms a peculiar narrow beam, and it is peculiar to each input port.
[0015] The input port 14 for a matrix is combined with the intersection network 20 through the hybrid coupler 22. It is constituted so that the input power between two output ports which have delayed 90 degrees of phases of an output port with the hybrid coupler near [it is desirable and] input port may be distributed equally. An intersection network is offered so that the position of the sequence of an output may be re-ordered without being prescribed by such two 2 x2 Butler matrices in a cascade and carrying out the electromagnetic coupling of the output all the time, while maintaining the stripline which crosses in one layer. a more detailed description of an intersection network is indicated by "the micro stripe and stripline intersection structure" (refer to 270 pages in the IEEE report about the theory and technology of microwave, and May, 1976) of J.S. WAITO, W.J. CHUDOBIAKKU, and V. MAKIOSU The hybrid coupler 24 has a power loss and a phase deviation property like a coupler 22, and it is offered in order for having intersected [which is a fast Fourier transform] perpendicularly to be by carrying out and to carry out combination of each input port to all output ports by the amplitude method. It

is combined with a matrix through the intersection network 28, and an output port 18 is combined with the hybrid coupler 24 so that an output port 16 may be shown. The composition shown in drawing 2 and 3 provides the system of this invention with narrow-beam transmission capacity.

[0016] Drawing 4 -7 illustrate the stratified composition for the integrated antenna array 10. As shown in drawing 4 and 7, the 1st (or top) layer 30 has the antenna element 32 arranged along with it. Desirably, an antenna element is prescribed by the array of the square of a patch antenna. However, the antenna element of a dipole, a monopole, and a slot is used for the antenna element by which others were known. Desirably, each patch antenna **********s into flow media, such as copper.

[0017] it is shown in drawing 4 -- as -- an integrated multilayer antenna array -- 34 includes the 2nd layer of the Butler matrix 12 in a perpendicular array it is shown in drawing 5 -- as -- an integrated multilayer antenna array -- 36 includes the 3rd layer of the Butler matrix 12 in a level array The Butler matrix arranged horizontally is supplied in order to arrange the phase sequence of numbers in alignment with the X-axis, and the Butler matrix arranged perpendicularly is supplied in order to arrange the phase sequence of numbers in alignment with the Y-axis. The 4th layer is the diode-switch matrix used in order to send a data transmission signal to the suitable Butler matrix input judged for [with 38 / optimal / which is roughly shown in drawing 6] transmission lines. With this operation form, a switch matrix is RF switch of 16 throw shown in drawing 8 which has two or more output ports 50 which were combined with the input port 48 and the control section 60 of the single pole, and which it has control line 44.

[0018] The flow Bahia hall 40 is used for the signal connection between an antenna element 32, the Butler matrix 12, and the switch matrix 38. These flow Bahia hall is a hole between the layers plated with flow material, such as copper, in order to form a show TINGU post between layers.

[0019] For the operation form of seven layers described for inside-of-a-house radio application, RF switch of seven throw of the single pole is controlled to choose among seven arrays by the control section 16. A perfect antenna array occupies the space of about 3 cubic inches (49.2 cubic centimeters) which offer the scope of a 360-degree directional beam when sharing the crevice between antennas and receiving the transmitted data, using an above-mentioned antenna array on the frequency of about 20GHz, and/or emit many narrow beams of about 15-degree beam width.

[0020] As shown in drawing 6 , the 4th layer is two steps of cascades of the diode switch 42 with the single pole of an array with 4 times slower 38. In order to choose a suitable port, bias voltage is applied to the bias track 44 corresponding to a port. With this composition, the diode array in each contact has a suitable property so that the stripline which had connection canceled may not lead too much parasitism reactance to a selection port. There is technology of a monolithic microwave integrated circuit (MMIC) as technology in which it is known for manufacturing such diode and/or a diode array like the stripline structure of an integrated array. As shown in drawing 6 , the DC block 46 (it essentially has permeability to RF) is used by the stripline, in order to insulate a bias circuit from a high-frequency signal.

[0021] The fragmentary sectional view of the multilayer antenna array 10 is illustrated by drawing 7 . Desirably, the 2nd of each integrated antenna array, the 3rd, and the 4th layer are manufactured using stripline structure, in order to suppress signal interference. The

parallel monotonous ground plane 52 is used with stripline structure, and thickness is for about 2 (0.0508mm) to 5 mils (0.127mm), and it is desirably manufactured by copper covering as shown. However, with the flow material of the type with which others are known, a metal and an alloy are used, for example. Moreover, parallel monotonous thickness changes with the flow media used. As shown in drawing 2 , the flow Bahia hall 54 between the ground planes put on the surroundings of a stripline is used for the mode suppression caused by the parallel monotonous mode of stripline structure. The flow Bahia hall 54 is a hole between each ground plane plated with flow material, for example, copper, in order to form the flow show TINGU post which has connected two ground planes of a stripline. The interval of each grounding plate is the ferrite substrate 56 with a thickness of 10 mils (0.254mm) which has the specific inductive capacity (epsilonr) of 2.39. As what is replaced with it, use of an alumina substrate with a thickness of 20 mils (0.508mm) which has the specific inductive capacity (epsilonr) of 9.0 is also possible.
[0022] Drawing 8 shows the typical communication system with which the integrated antenna array is incorporated. This system is constituted so that the signal path which has the distortion factor which fills the threshold beforehand determined as the signal-to-noise ratio may be judged and chosen. A system 10 contains the integrated multilayer switch TOBIMU antenna array 12, the above-mentioned transmitter-receiver network 58, and an above-mentioned control section 60.
[0023] As it mentions above and is shown in drawing 8 , an antenna array processes by carrying out the sample of the received data transmission, and is included in the high-speed communication system which judges the transmission line of the optimal transmitter antenna and a receiver antenna.
[0024] As mentioned above, the contents of this indication include use of a signal-to-noise ratio and a multipath strain parameter, in order to judge the optimal transmission line. Thus, in order to judge whether transmission of the received data is less than the threshold as which it reached [whether the signal-to-noise ratio is over the threshold defined beforehand, and], and the signal strain parameter was determined beforehand, sampling and processing are performed. The sample of the transmitter-receiver circuit 58 and the control section 60 is swept and carried out through the signal received from each receiving sector (for example, each 16 beams of each seven antenna array) which is a total of 112 beams. A transmitter-receiver circuit contains the equipment of standard marketing. Reference of U.S. patent No.4,612,518 besides Guns indicates the modulator / demodulator method used in a transmitter-receiver circuit. A control section processes the received signal and judges the signal-to-noise ratio and strain parameter of each beam. And when a receiver and a specific transmitter transmit data, a control section 60 creates the data table which relates the best receiver sector with a specific transmitter sector so that a storage sector may be used. A control section 60 is a processor control unit which has memory, the storing program which controls transmitter-receiver logic and a switch matrix, and the storing program which judges the optimal transmission line described below. As a suitable example of a control section, there is a Hewlett Packard VXI bus controller model HP75000.
[0025] In addition, a control section 16 stores a signal-to-noise ratio and the threshold to a strain defined beforehand, monitors the received signal continuously, and when a strain exceeds a threshold when a signal-to-noise ratio is less than a threshold and/or, in order to judge the best path, it samples a signal again. In order to judge which receiver sector [

which transmitter sector and] are best, the signal received is sampled continuously and there is other technology of judging which path being best.
[0026] Desirably, in order to judge a signal-to-noise ratio and a signal strain parameter, an "eye opening" method is used. The "eye opening" method is indicated and learned by the "digital transmission theory" (refer to 278 pages in a plaque teeth hole book company and 1987) of S. Benedetto, E. BIGURAIRI, and V. dregs TERANI.
[0027] Probably, it turns out that it is possible to add various change to the operation gestalt of this invention indicated here, without separating from the meaning and scope. For example, in addition to the flow and dielectric material various type for the integrated layer structures of an antenna array, an antenna element various type can be considered. Therefore, the upper publication is not as what restricts this invention, and should only be interpreted as an example of the desirable operation gestalt. the specialist of the technology of these can imagine other modifications in the scope of this invention specified by the claim indicated, and the meaning -- I will come out

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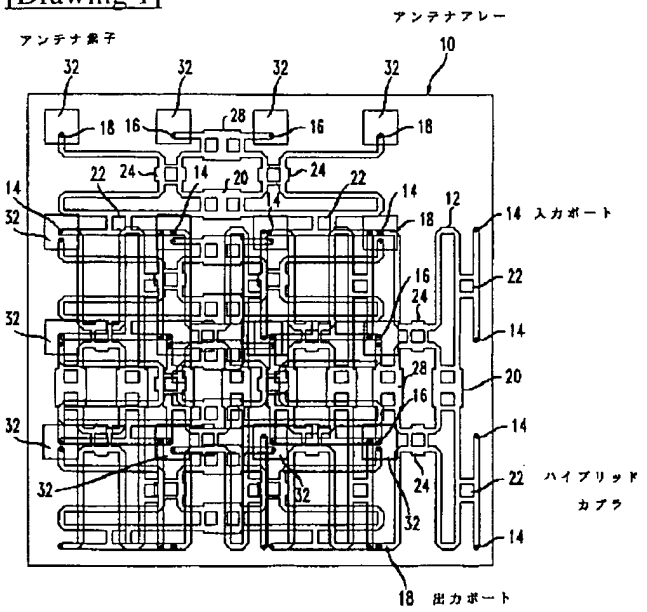
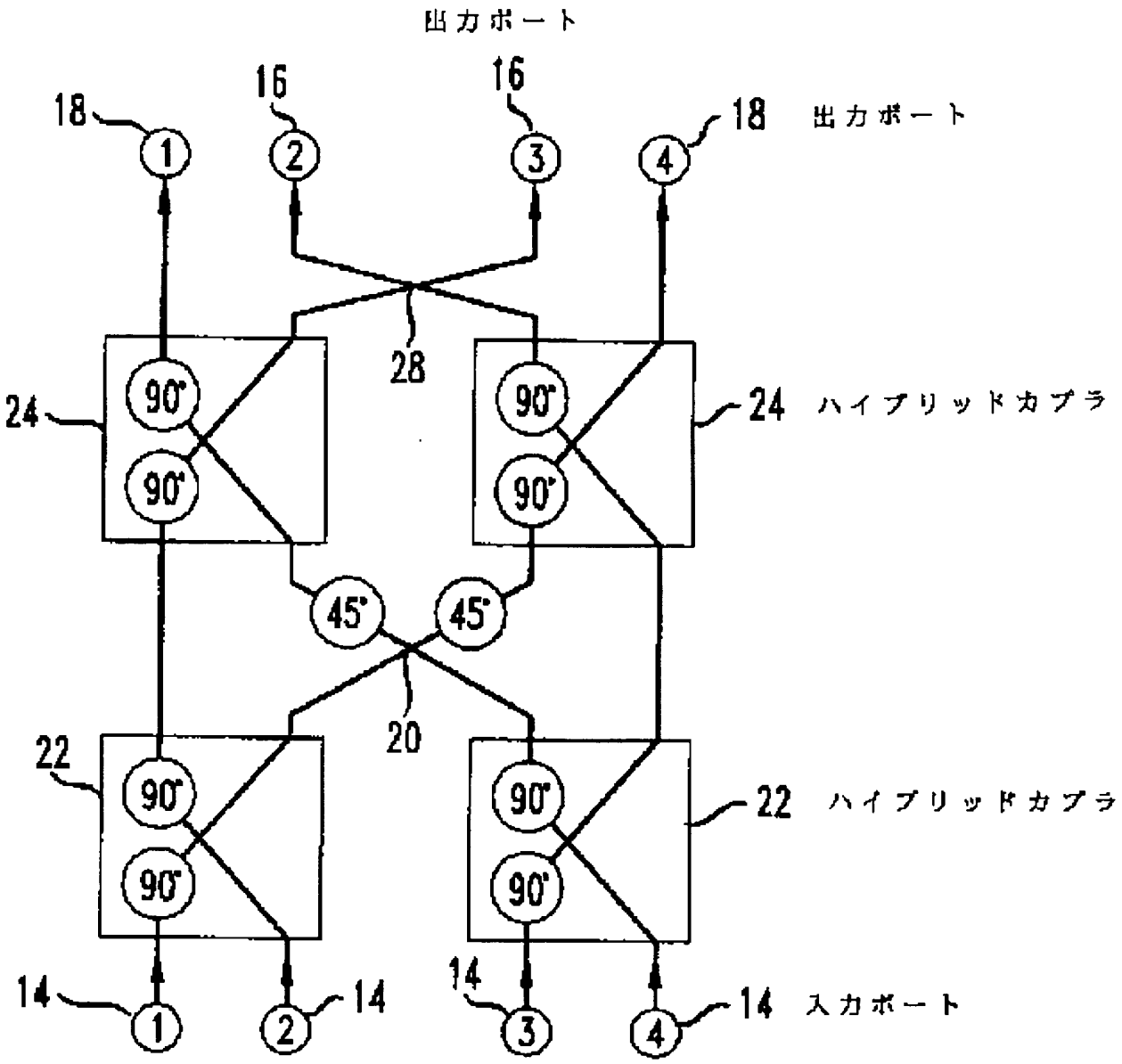
DRAWINGS

[Drawing 1]



[Drawing 3]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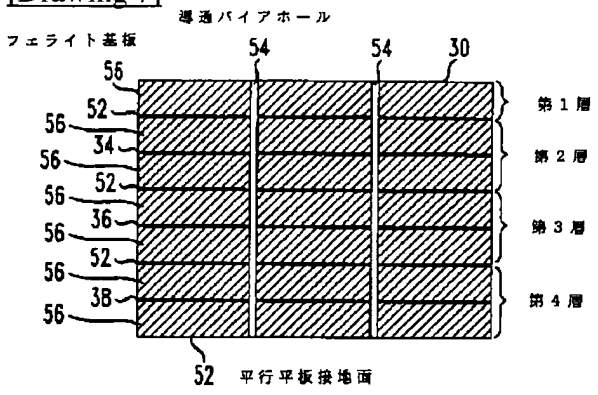
[Drawing 7]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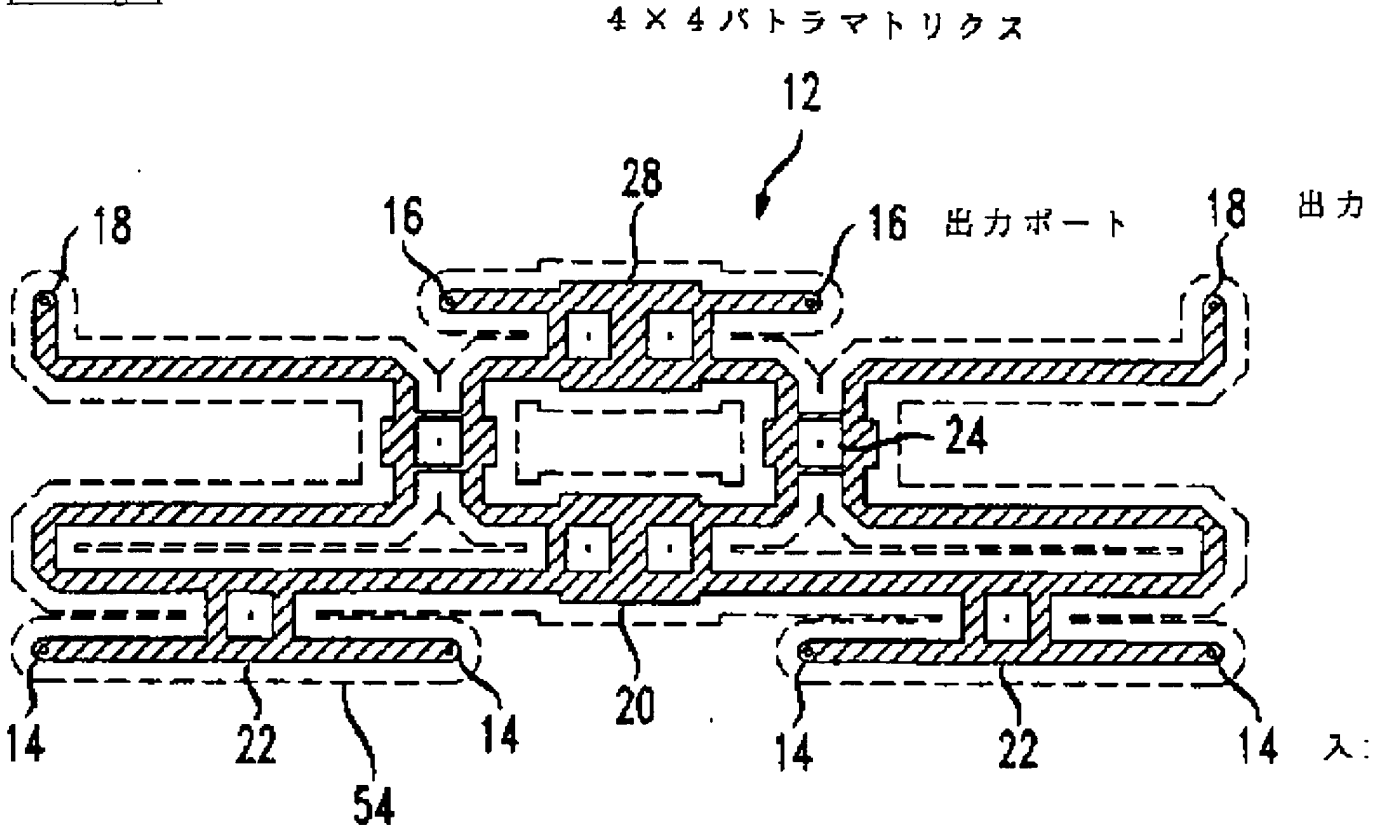
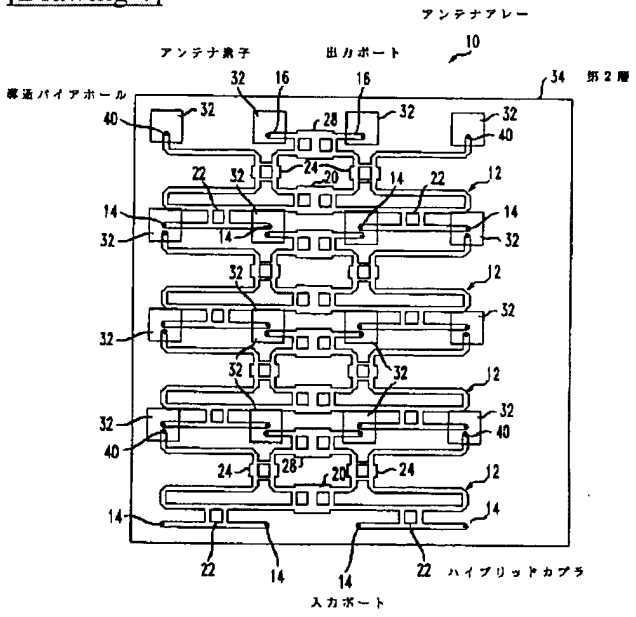
第2層
第3層
第4層
52
平行平板接地面

[Drawing 2]



[Drawing 4]



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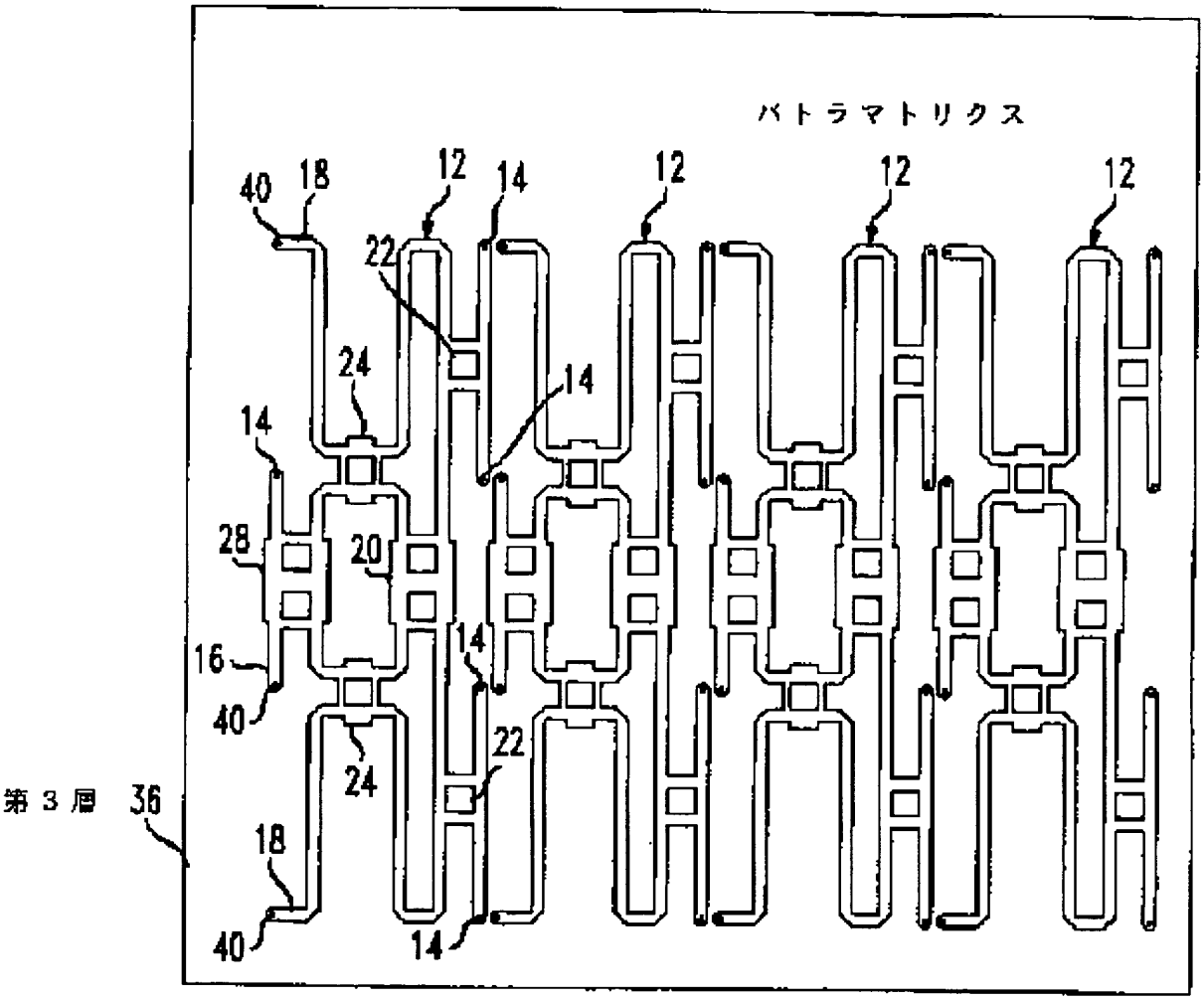
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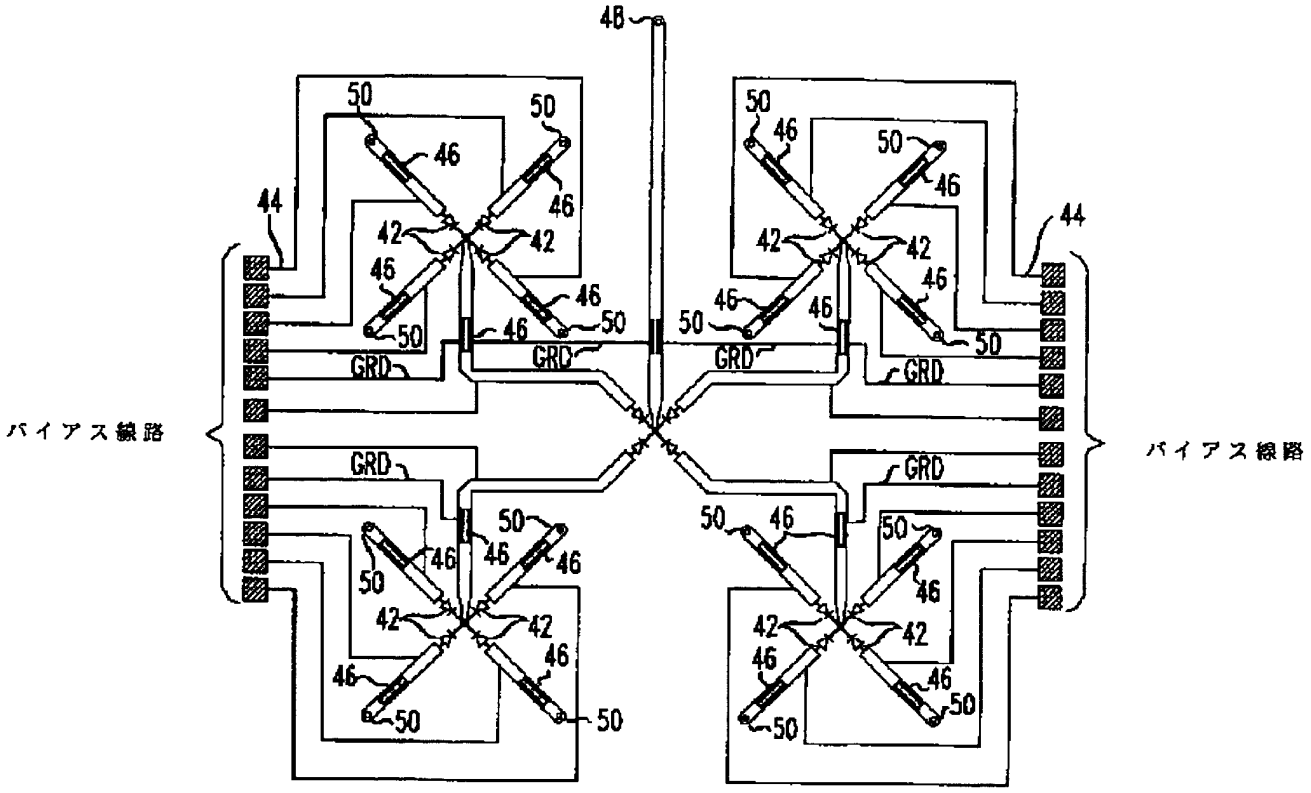
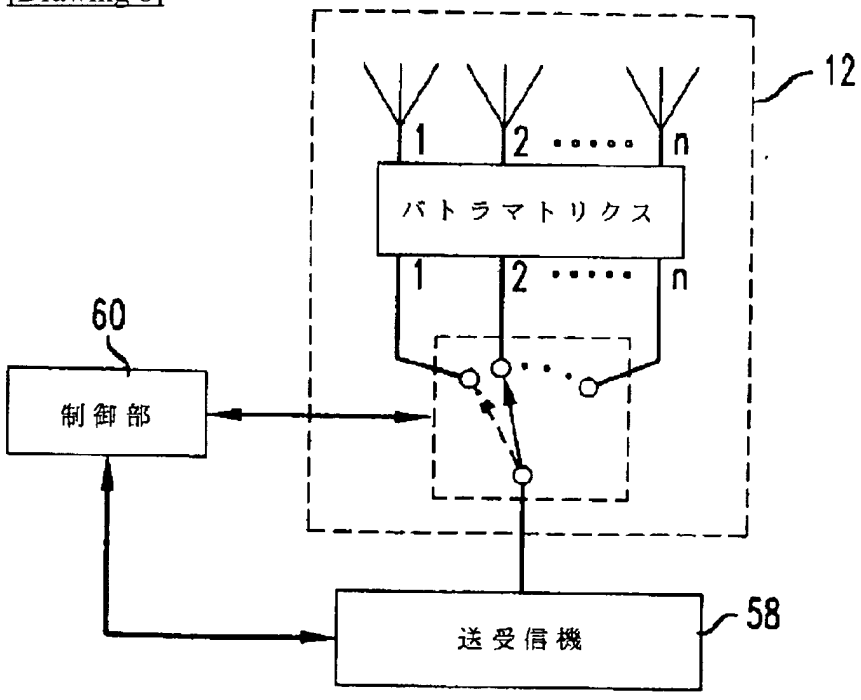
[Drawing 6]



[Drawing 8]



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